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Upgrade of the 92 GHz Airborne Multi-channel Meteorological Radiometer (AMMR)

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The AMMR 92 GHz dual polarized radiometer (AMMR-92) has been used to perform experiments in the Laboratory for Radioscience and Remote Sensing at Georgia Tech during two periods, the first period was from March 1991 to November 1992, and the second period was from March 1993 to September 1993. Early in the first period a polarization correlation channel was added to the radiometer. This new channel can be configured to measure the third ($Re\langle E_v E_h^* \rangle$) or fourth ($Im\langle E_v E_h^* \rangle$) Stokes parameter in the radiometer's feedhorn polarization basis. Operation of the instrument as a polarization correlating radiometer does not affect its originally intended operation as a dual-polarized radiometer.

Investigations with the AMMR-92 at Georgia Tech have uncovered some problems which may compromise the accuracy of the instrument. These problems are not related to the installation of the new cross-correlating channel but are inherent in the original design. The following is an outline and summary of our observations of the instrument with suggestions for their correction and upgrade of the AMMR-92 radiometer.

1. Splash-plate alignment

- (a) Squint in the main antenna beam ($\sim 7^\circ$)
- (b) Rotation of feedhorn basis ($\sim 15^\circ$)
- (c) Inaccurate calibration

2. Replacement of calibration loads with pyramidal type

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3. Mixer upgrade

- (a) Reduce instrument receiver noise
- (b) Balance receiver noise temperatures

4. Install a video blanking circuit

1. Splash-plate Alignment

The main beam of the instrument and its polarization basis are not properly aligned with the window mount attached to the radiometer. Due to these internal alignment problems the main beam of the instrument is directed $\sim 9.5^\circ$ forward of the desired broadside look angle (90°) when mounted on the port side of an airborne platform. Additionally, the polarization basis of the main beam is rotated 15° (clockwise, as observed when facing the instrument). The rotation causes undesirable measurement errors due to polarization mixing of the vertical and horizontal channels. During calibration of the instrument it was also found that observations of the internal calibration loads were scene dependent. It is likely that all three of the above problems are caused by misalignment of the internal "splash-plate" responsible for directing the main beam toward the scene, or toward the HOT or COLD loads. The "splash-plate" needs to be realigned.

2. Replacement of Calibration Loads

Inspection of the calibration loads in the AMMR-92 radiometer indicate that at least one of the internal blackbody loads is a wedge-type load (not pyramidal). To obtain high emissivity for both orthogonal polarizations this load should be replaced with a pyramidal type load. The HOT and DICKE loads can be easily viewed from outside the radiometer, however, the COLD calibration load was not inspected while the radiometer was at Georgia Tech due to its inaccessibility. It is recommended that this load be inspected and if necessary, also replaced with a pyramidal type load. The use of wedge-type loads in a dual-polarized radiometer is not satisfactory and as discussed above, can promote errors in the measured brightness difference T_{v-h} .

3. Mixer Upgrade

The receiver noise temperatures of the AMMR-92 were measured in the laboratory at Georgia Tech and found to be 1600 K and 2800 K for the vertical and horizontal polarizations respectively. These values are well above the current state-of-the-art performance ($\lesssim 650K$). Significant improvement of the instrument sensitivity would result from an upgrade of the instrument's mixers. A mixer upgrade should result in equal noise temperatures for both (vertical and horizontal) polarization receivers.

Video Blanking Circuit

Considering the geometry of the chopper wheel currently used on the AMMR-92, it is hypothesized that during a significant part of the phase-sensitive detectors (PSD) integration time the edge of the chopper wheel is in the field of view (FOV) of the main beam. It has been proposed that a circuit be incorporated into the instrument for blanking the PSD video input during the Dicke switch transition. This should improve the sensitivity of the instrument by reducing variations (noise) in the PSD input signal during the transition. A circuit has been built in the laboratory at Georgia Tech to perform this function and can be used to determine the potential advantages to be gained by video blanking.